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SEED DISTRIBUTION IN THE SWATH FROM HELICOPTER SOWING

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Seeds of herbaceous plants were sown by helicopter on 13,496 acres at the San Dimas Experimental Forest in 1960 after it had been burned over by a wildfire. On 88 small areas of 3 to 103 acres in size, seventeen species were tested in various combinations to determine their effectiveness as watershed cover, and most of the species also were sown on larger areas.

For the small plots, rice hulls were added to each seed mixture so that all mixtures were of equal volume per acre. All these mixtures with rice hulls for a series of plots were sown with a single calibration of the seeders on the helicopter. For the large areas, the seeders were recalibrated for each seed mixture, and each was sown without the addition of rice hulls.

Plans for these operations raised questions concerning distribution of the seed: Would seed be evenly distributed within a swath? Would small seed tend to separate from the larger seed, with or without rice hulls? Would addition of rice hulls affect the over-all seed distribution? Would seed of some species drift more than others in the wind? To answer these questions, a test of seed distribution in the swath was made at the start of the sowing operations.

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Procedure

A flight course was laid out along a bulldozed trail on a ridge-top (fig. 1). Extending a distance of nearly one-fourth mile, the course changed slightly in direction at two points but in general was oriented in a north-south direction.

Four sampling transects across the course were located at intervals of 300 feet. Each transect had a sampling station at the center of the course, and at intervals of 10 feet horizontal distance on either side of the center. Slopes beyond the bulldozed trail broke away at gradients of 30 to 70 percent. At each station a paper plate was set level and filled with water to form a collection area of 0.44 square foot.

Three individual species and seven mixtures were sown, each with a single pass of the helicopter over the course.

Each of the two seeders on the helicopter was recalibrated before each species or mixture was sown, except that all mixtures with rice hulls were sown with one calibration. Rate of seed movement from the hopper of each seeder was regulated by setting a notched slide. Each seeder was equipped with a wire agitator in the bottom of the hopper, a shut-off gate, and a blower, operated by separate electric motors. The blower regulated spread of the seed from the flat, fan-shaped distributor.

Flying height and speed down the center line of the course were approximately 50 feet and 45 miles per hour. This was intended to produce a 40-foot swath with sufficient overlap.

After each pass of the helicopter the seeds in each plate were counted or were collected in an envelope for later counting (fig. 2), and the plate refilled with water.

The test was completed between 6:45 and 10:15 a.m. October 25, 1960. The air was exceptionally calm during this period. It varied from nil to 4 miles per hour most of the time but increased to 6 or 7 miles per hour for periods of a few seconds to half a minute. Wind direction was northeasterly except in the last trials, when it was south to southwest.

Over-all Seed Distribution

The total amount of seed in each mixture was well distributed over a 40-foot swath--the swath width used in the sowing operations on the experimental forest. The average catch from 4 transects in each of the 10 tests is shown in table 1. The coverage of a 40-foot swath was rated good in all but 6 of 40 transect counts. In about one-fourth of the 40 transects, the coverage was good over a 50-foot swath.

More seed was collected at the center two stations than at the outer two in each 40-foot swath. As an average of the 10 tests, about

Figure 1.--Helicopter sowing a trial swath along the flight course.

Figure 2.--Technician collecting seed from plate at a station on the center line of the flight course.

Table 1.--Distribution of total seed in helicopter-sown swath, as affected by addition of rice hulls and by wind speed and direction

Seed mix or species, and rice hull addition	Wind		Sample locations									
			Feet West					Center line	Feet East			
	Speed	Direction	50	40	30	20	10		10	20	30	40	50
	Mi./hr.		Number of seed per square foot 1/										
Perennial No. 1													
No hulls	2-5	ENE	0	37	90	114	118	98	66	6	0	0	0
With hulls	0-2	SSW	0	0	0	24	60	114	209	76	38	0	0
Perennial No. 2													
No hulls	0-3	E	0	2	11	62	111	79	73	40	0	0	0
With hulls	0-3	S	0	0	0	10	52	65	69	74	17	0	0
Perennial-annual													
No hulls	1-3	ENE	0	2	24	81	132	122	64	8	0	0	0
With hulls	0-2	S	0	0	0	2	29	64	98	152	42	20	2
Ryegrass-Blando													
No hulls	3-4	NE	0	2	21	42	83	87	62	32	0	0	0
Ryegrass													
No hulls	4-6	ENE	0	11	41	108	113	104	44	0	0	0	0
Blando brome													
No hulls	0-3	SSW	0	0	2	9	18	32	85	50	25	7	0
Mustard													
No hulls	2-5	ENE	2	14	32	62	73	70	57	27	2	0	0

1/ Average of 4 sample stations.

half of the total seed was collected at the center two stations and one-third at the outer two stations. The remaining seeds fell outside of the 40-foot swath, to provide overlap on adjacent swaths. In operational sowing this overlap equalizes the catch at all points.

In all but two swath tests, virtually 100 percent of the seed fell within a 60-foot swath. The seeds of Blando brome and black mustard were more widely dispersed, only 95 percent falling within the 60 feet. The round mustard seeds were more widely spread than the grass seeds.

Addition of rice hulls to the mixtures had no marked or consistent effect on distribution of total grass seed (table 1). The hulls themselves were distributed much the same as the grass seeds, but over less total width of swath.

Light winds caused consistent downwind drift of the entire swath (table 1). With wind speeds below 3 or 4 miles per hour the drift was about 5 to 10 feet, or less. Winds up to 6 miles per hour across the flight line caused as much as 15 feet of drift. A shift in wind direction during the swath tests caused a variation in swath center from about 10 feet west of the flight line to about 10 feet east of it.

In the large-scale sowing on the experimental forest, flying was stopped when wind speed reached 10 miles per hour. Sowing of small plots was done with low wind and little drift of seed.

Distribution of Individual Species

Average seed distribution was good for each species at the rates sown (table 2). Distribution was also good in each sample transect for all except a few trials at rates of about 1 pound per acre.

The sowing rates for the grass species, with one exception, were about twice the rates at which the species were sown in the large-scale operations on the experimental forest. Mustard was sown at about three times its regular rate. The higher rates in the swath tests were caused by consistently high calibrations of the seeders, a problem not encountered in the regular operations.

The average sowing rates (table 2) were only approximate, as calculated from (1) numbers of seed of each species caught per square foot in each swath, and (2) numbers of seed per pound for each species. Relative sowing rates for all species in a mixture agreed closely with the weight proportions of the various species in the mixture, indicating that the calculated sowing rates were close to the actual rates.

Examination of all the samples indicated that the individual species could have been sown at much lower rates per acre with uniform seed distribution. The small-seed species, with many seed per pound, of course, spread more uniformly at a low rate than the species with larger seed.

Table 2.--Distribution of seed in helicopter-sown swath, by species and sowing rate

Species	Average rate of sowing[1]	Sample location[2]									
		Feet					Feet				
		45	35	25	15	5	5	15	25	35	45
	Lbs./acre	Number of seeds per square foot[3]									
Ryegrass	20.2	0	0	11	41	108	113	104	44	0	0
	12.0	0	2	9	25	61	64	45	23	0	0
	6.4	0	0	1	15	24	26	25	4	1	0
	0.8	0	0	1	3	3	5	3	1	0	0
Blando brome	9.7	2	9	18	32	85	50	25	7	0	0
	3.0	0	0	11	16	20	23	16	9	0	0
	0.8	0	0	1	4	5	5	5	2	0	0
Big bluegrass	1.7	0	2	11	28	43	28	26	10	0	0
Orchard grass	4.3	0	1	9	28	39	59	51	11	7	1
	1.6	0	1	3	11	20	15	14	4	0	0
Smilo	1.7	0	2	5	16	28	26	15	4	0	0
Hardinggrass	5.1	0	0	9	27	38	52	27	13	0	0
Wheatgrasses	9.6	0	0	2	11	18	19	16	5	0	0
	8.6	0	0	3	10	24	23	9	3	0	0
	6.8	0	0	4	9	15	18	11	1	0	0
Tall fescues	2.2	0	0	2	11	13	12	7	1	0	0
	1.6	0	0	0	4	7	7	5	2	0	0
Mustard	15.4	2	14	32	62	73	70	57	27	2	0

1/ Calculated from total seed caught for each mixture in each swath trial, based on counts of seed per pound.

2/ Number of feet west and east of the center of each swath rather than from the center line of the flying course.

3/ Average of 4 to 24 sample stations.

The small-seed species--Hardinggrass, smilo, big bluegrass, and orchard grass--were well distributed in all transect samples. Overlap outside of the 40-foot swath was good with all four of this group, but was considerably wider for big bluegrass and orchard grass, which had the lightest seed. Orchard grass seed drifted most in the wind. For three of the four species in each trial swath, the number of seed caught per square foot agreed almost exactly with the calculated average sowing rate. Smilo was consistently caught at a slightly lower rate than calculated.

The large seeds of the wheatgrasses were well distributed, but spread was limited to little more than the 40-foot swath. Sowing rates for individual swaths did not coincide exactly with the calculated average sowing rate, indicating less perfect distribution than for the small-seed species. At low sowing rates the few wheatgrass seeds per square foot might be erratically distributed.

The seeds of more medium size--ryegrass, tall fescue, and Blando brome--were well distributed except for a few sample transects sown at only about one pound per acre. At a calculated average rate of 0.8 pound per acre, the actual catch of ryegrass seed and brome did not always correspond with the expected catch, but the average figures did agree closely for the two species combined.

Blando brome was the only grass species having seed which did not flow freely and uniformly through the hopper. Mixtures containing as little as 5 percent by weight of this species did not flow freely. Consequently, the mixtures with Blando brome were sown at a lower rate in the swath tests than were mixtures which did not contain it, regardless of whether rice hulls were added. The reduction was compensated for by recalibration of the seeder in large-scale sowing operations. When sown alone in the swath tests, Blando brome was caught at about one half the rate which would be expected from sowing an equally bulky mixture of other species and rice hulls. This also was the case in later sowing of plots, and consequently Blando brome plots were flown twice to obtain the desired rate of sowing.

Mustard, not sown in mixture with other species in the swath tests, did not combine well with ryegrass during large-scale sowing operations. The mixture of these two species obviously would not be so uniformly distributed as were the grass mixtures used in the swath tests.

The swaths of individual grasses sown in mixtures, drifted with the wind in the same manner as the total mixtures. With few exceptions, the 40-foot swath of a species coincided with the swath of the entire mixture. In the stronger winds some of such light seeds as orchard grass and Blando brome probably drifted farther than large-seeded species like wheatgrass.

Addition of rice hulls had no important effect on distribution of the seed of individual species. Apparently the hulls are not needed to prevent separation of the small-seed species from the mixture when sown by helicopter.

Conclusion

The swath tests showed that grass species with seeds of different sizes and shapes could be combined in mixtures and sown by helicopter with good distribution. The seeds of all species were uniformly distributed over a 40-foot swath, with adequate overlap. The large chaffy seeds of wheatgrasses were less widely spread than the seeds of other species. Addition of rice hulls to prevent separation of small seeds from the mixture did not prove necessary. Location of the swath was changed slightly by light cross winds, but the effect was about the same for seed of each species.